



Nissan Engineering Standard

NES	Steels for Automotive Use	M1010 Revised 1988
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Reference Standard : Shown in Pages 48.

2.2 The classification and symbol of the carbon and alloy steels S(H steel) for machine structural use and free-cutting steel, (hereinafter referred to as "steels") shall be as given in Table 3.

Table 3 Classification of steel and symbol

Classification of steel		Symbol	
Carbon steel		S12C S15C S20C S25C S30C S33C S35C S38C S40C S40C-N S43C S45C S48C S48C-N S50C S53C S55C S55C-N	
H steel	Manganese steel	SMn443H	
	Chromium steel	SCr415H SCr417H SCr420H SCr440H SCr445H	
	Mangan-Chromium-Boron Steel	MCB240H MCB440H	
	Chromium-molybdenum steel	SCM415 SCM418H CM320H SCM420H SCM822H CM427H SCM435H SCM440H SCM445H	
	Nickel-chromium steel	SNC415H	
	Nickel-chromium-molybdenum steel	SNCM220H SNCM222H SNCM420H	
Free-cutting steel	Pb-free-cutting steel	...L ...L1	
	S-free-cutting steel	...S1	
	Ca-free-cutting steel	...U	
	Ca-S-free-cutting steel	...US1 ...US2	
	Ca-trace, Pb-free-cutting steel	...UL1	

Remarks: The free-cutting steel is denoted by the symbol of the fundamental steel, added with L, L1, S1, U, US1, US2 or UL1.

Example: Ca-free-cutting steel of the fundamental S53C...S53CU, Pb-free-cutting steel of the fundamental S48C...S48CL1.

2.3 The classification and symbol of the cold-finished steel shall be as follows:

- (1) Steel bar, cold-drawn for improving its mechanical properties. To be denoted by the symbol of the hot-rolled steel, added with -D. (The material will be hereinafter referred to as "D material").
- (2) Steel bar, mainly for maintaining its dimension accuracy etc. and not particularly requiring its improved mechanical properties. To be denoted by the symbol of the hot-rolled steel, added with -S. (The material will be hereinafter referred to as "S material").
- (3) Steel bar and wire, specified particularly in mechanical properties, heat treatment, surface treatment by coating etc. for maintaining its sufficient formability in cold pressing. To be denoted by the symbol of the hot-rolled steel, added with -E. (The material will be hereinafter referred to as "E material").

Remark: Some of the cold-finished steel, specified particularly in grinding or cutting out of necessity shall be denoted by the symbol added with -G or -T, respectively.

Table 5 Chemical composition of alloy steel
for machine structural use (H Steel)

Units: (%)

Symbol	C	Si	Mn	P	S	Ni	Cr	Mo	B	Others
SMn 443 H	0.39 ~0.46	0.15 ~0.35	1.30 ~1.70	≤0.030	≤0.030	—	≤0.35	—	—	
SCr 415 H	0.12 ~0.18	0.15 ~0.35	0.55 ~0.90	≤0.030	≤0.030	—	0.85 ~1.25	—	—	
SCr 417 H	0.15 ~0.20									
SCr 420 H	0.17 ~0.23									
SCr 440 H	0.37 ~0.44									
SCr 445 H	0.42 ~0.49									
MCB 240 H	0.37 ~0.44	0.15 ~0.35	0.80 ~1.20	≤0.030	≤0.030	—	0.30 ~0.70	—	0.0010 ~0.0030	
MCB 440 H			0.80 ~1.10				0.70 ~1.10			
SCM 415 H	0.12 ~0.18	0.15 ~0.35	0.55 ~0.90	≤0.030	≤0.030	—	0.85 ~1.25	0.15 ~0.35	—	Cu ≤ 0.30 Ni ≤ 0.25
SCM 418 H	0.15 ~0.21							—		
CM 320	0.17 ~0.23						1.00 ~1.30	0.06 ~0.10		
SCM 420 H	0.17 ~0.23						0.85 ~1.25	0.15 ~0.35		
SCM 822 H	0.19 ~0.25							0.35 ~0.45		
CM 427	0.24 ~0.28							—		
SCM 435 H	0.32 ~0.39						0.85 ~1.25	0.15 ~0.35		
SCM 440 H	0.37 ~0.44							—		
SCM 445 H	0.42 ~0.49							—		
SNC 415 H	0.11 ~0.18	0.15 ~0.35	0.30 ~0.70	≤0.030	≤0.030	1.95 ~2.50	0.20 ~0.55	—		
SNCM 220 H	0.17 ~0.23	0.15 ~0.35	0.60 ~0.95	≤0.030	≤0.030	0.35 ~0.75	0.35 ~0.65	0.15 ~0.30		Cu ≤ 0.30
SNCM 222 H	0.19 ~0.25		—			—				
SNCM 420 H	0.17 ~0.23		0.40 ~0.70			1.55 ~2.00				

5. MECHANICAL PROPERTIES OF COLD-FINISHED STEEL

5.1 The mechanical properties of the D material shall conform to Table 8.

Table 8 Mechanical properties of the D material

Symbol	Tension test				Hardness test		Bending test	
	Tensile strength (kg/mm ²) (N/mm ²)	Yield point (kg/mm ²) (N/mm ²)	Elongation (%)		HRC	HRB	Bending radius	Bending angle, deg (°)
			No. 2	No. 4				
SS 41-D	≥ 50 (490)	≥ 40 (392)	—	—	—	70~90	2.5x diameter or width across flats	180
S 12 C-D	≥ 50 (490)	≥ 42 (412)	≥ 9	≥ 13	—	82~93	—	—
S 15 C-D	≥ 52 (510)	≥ 43 (422)	≥ 9	≥ 13	—	83~94	—	—
S 20 C-D	≥ 55 (539)	≥ 44 (431)	≥ 7	≥ 12	—	85~95	—	—
S 25 C-D	≥ 56 (549)	≥ 45 (441)	≥ 7	≥ 12	—	86~96	—	—
S 30 C-D	≥ 58 (569)	≥ 46 (451)	≥ 7	≥ 11	—	87~97	—	—
S 33 C-D	≥ 62 (608)	≥ 50 (490)	≥ 6	≥ 10	—	90~100	—	—
S 35 C-D	≥ 62 (608)	≥ 51 (500)	≥ 6	≥ 10	—	90~100	—	—
S 38 C-D	≥ 64 (628)	≥ 51 (500)	≥ 6	≥ 10	—	92~102	—	—
S 40 C-D	≥ 65 (637)	≥ 52 (510)	≥ 6	≥ 10	13~25	—	—	—
S 43 C-D	≥ 67 (657)	≥ 53 (520)	≥ 5	≥ 9	16~26	—	—	—
S 45 C-D	≥ 69 (677)	≥ 55 (539)	≥ 5	≥ 9	16~26	—	—	—
S 48 C-D	≥ 72 (706)	≥ 57 (559)	≥ 5	≥ 9	18~27	—	—	—
S 50 C-D	≥ 73 (716)	≥ 58 (569)	≥ 5	≥ 9	18~27	—	—	—
S 53 C-D	≥ 76 (745)	≥ 60 (588)	≥ 4	≥ 8	20~28	—	—	—

Remarks:

1. Table 8 shall be applied to the D material 25 mm and below in diameter or width across flats. The mechanical properties of the D material 25 mm and over shall be decided by the agreement between orderer and manufacturer.
2. Bending test of the bar manufactured from the hot rolled for general structures shall be carried out with its specimen 26 mm and below in diameter or width across flats.
3. If agreed upon between the orderer and the manufacturer, bending test can be applied to the carbon steel for machine structural use.

5.2 The mechanical properties of unfinished S material shall conform to Reference Table 1 (2).

5.3 The mechanical properties of the E material shall be decided by the agreement between orderer and manufacturer.

6. HARDENABILITY

6.1 Hardenability of alloy steel for machine structural use of guaranteed for hardenability (hereinafter referred to as H steel), shall satisfy the values given in Table 9 as well as diagram 1~22.

7. GRAIN SIZE

The grain size of the steels shall conform to Table 10. Any existence of duplex grain is not tolerated.

Table 10 Grain size

Classification of the steels	Grain size number
For carburizing	Mean grain size for carburizing ≥ 6.0
For thermal refining	Mean grain size for heat-treatment ≥ 5.0

8. DECARBURIZATION

- 8.1 As for the decarburized layer, it is possible to distinguish between the total and the practical use. The depth of the practical decarburized layer shall be 0.3 mm and below, however provided that, that of such particularly specified steels as cold-finished steel etc. shall be decided by agreement.
- 8.2 For the estimation of the depth of practical decarburized layer, its hardness measured according to section 14.6 shall be always higher than the value shown in Table 11.

Table 11 Depth of practical decarburized layer

C (%)	Hardness (H_{RC})
≥ 0.15	30
≥ 0.20	35
≥ 0.30	40

- 8.3 The depth of decarburized layer shall be indicated in mm unit down to two and one places of decimals for the total and the practical, respectively. The depth of total decarburized layer shall be indicated with T put before its numerical value.

Example: When the depth of total decarburized layer is 0.15 mm T 0.15

9. HARDNESS

- 9.1 Hardness of the steels as hot working

As a rule, the hardness at the time of delivery, of the carbon steel for machine structural use as hot working shall conform to Table 12.

Fig. 1

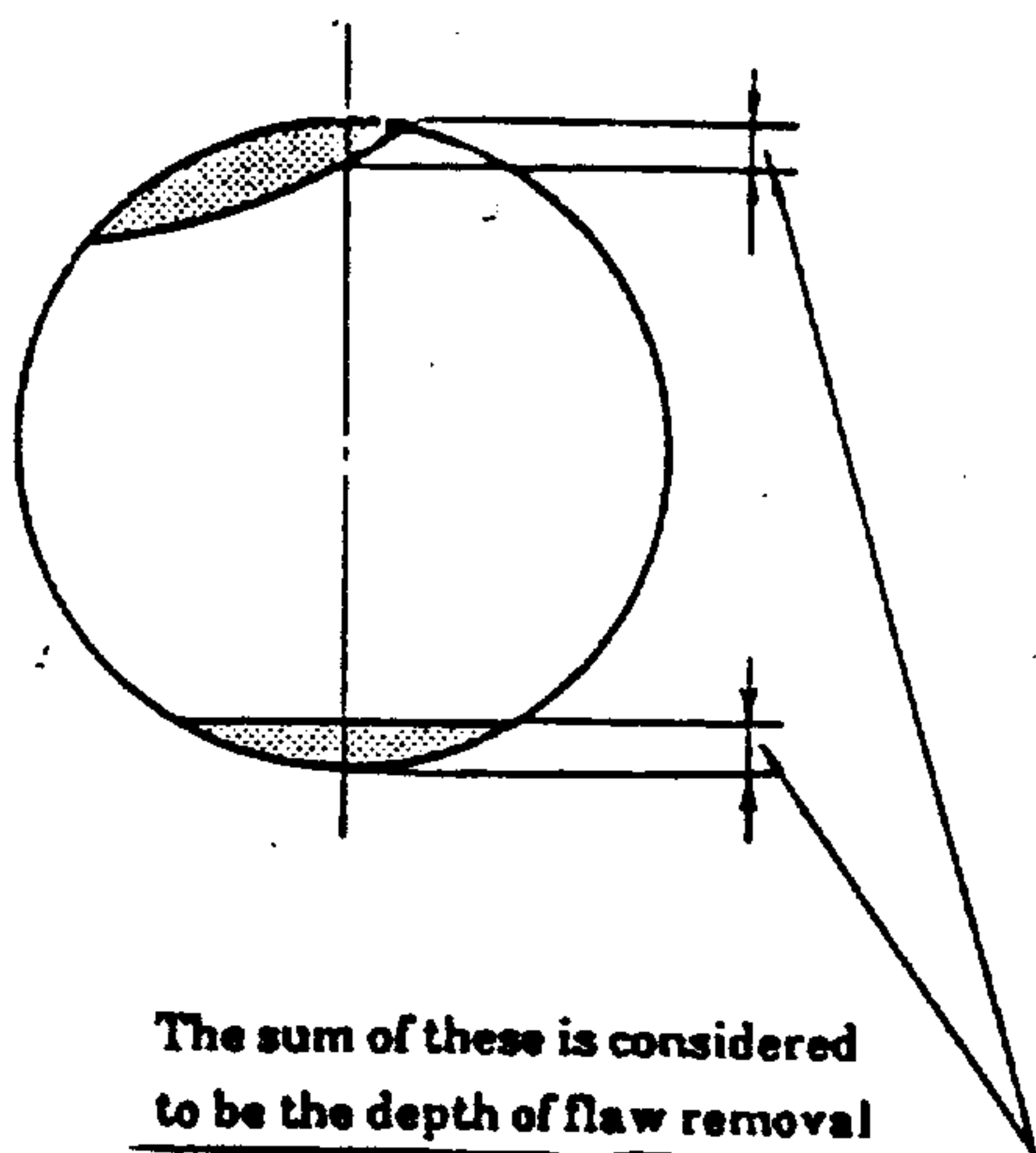
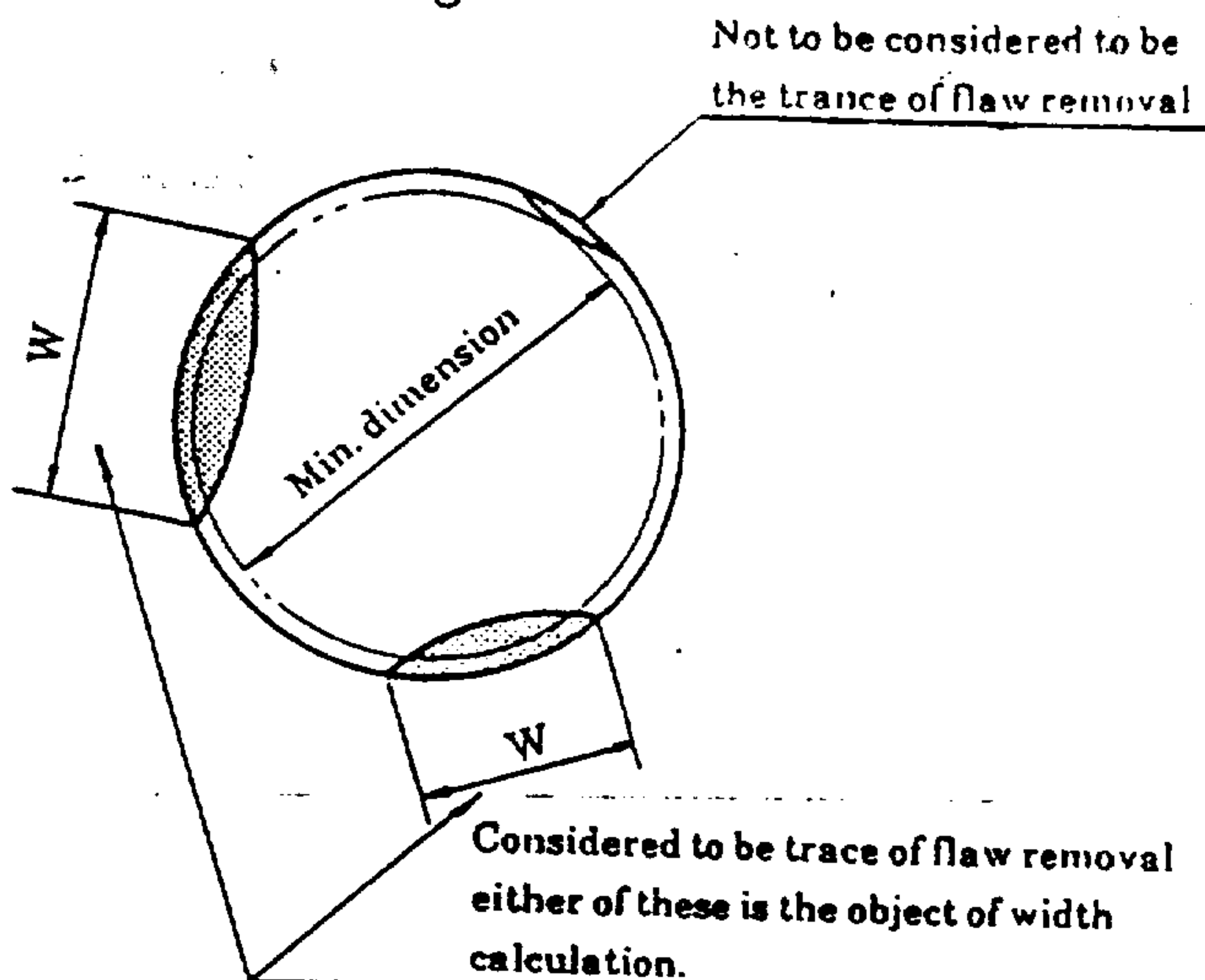


Fig. 2



- 10.2.2 On the same cross section, the sum of the widths of flaw removal shall be a quarter and below of the circumference, provided that any place of flaw removal outside the minimum size is not considered to be the trace of flaw removal (Fig. 2).
- 10.2.3 The permissible size of residual flaw in the steel for general forging shall be decided by the agreement between the orderer and manufacturer.
- 10.2.4 As a rule, round bar for direct cutting may dispense with flaw removal. The permissible depth of flaw removal shall be equal to or below than 1% of the nominal size in mm (to be rounding off of down to one place of decimal) plus 0.4 mm.

Remark: As to rules for rounding off of numerical values, refer to JIS Z 8401 "Rules for Rounding off of Numerical Values".

Example:

Nominal diameter (ϕ mm)	1% of nominal diameter plus 0.4 (mm)	Permissible depth of flaw removal (mm)
28	0.68	0.7
34	0.74	0.7
50	0.9	0.9
60	1.0	1.0
65	1.05	1.0
85	1.25	1.2

13.2 Standard length

The standard length of the steels shall be as given in Table 16, provided that the length range can be modified by the agreement between orderer and manufacturer.

Table 16 Standard length

Kind	Standard length (mm)
Hot-rolled steel	5000 ~ 6000
Cold-finished steel	3000 ~ 4000

Permissible short-length material shall be decided by the agreement between orderer and manufacturer.

Material specified to be multiple-length shall have a length (give the name of multiple-length material), which is equal to integral multiples of the unit length within the range of standard length, Table 16 and in this case the tolerance over the whole length be $\begin{smallmatrix} +40 \\ 0 \end{smallmatrix}$ for the hot-rolled steel and $\begin{smallmatrix} +100 \\ -0 \end{smallmatrix}$ for the cold-finished steels, but $\begin{smallmatrix} +40 \\ -0 \end{smallmatrix}$ for the cold-finished steels produced from steel coils.

13.3 Dimension tolerance

(1) The dimension tolerance of the hot-rolled steel (round and square bars) shall comply with Table 17.

Table 17 Dimension tolerance of the hot-rolled steel (except wire rod)

Unit: mm						
Dimension Standard	Symbol	F	L	M	K	J
	Application example	Material for general forging		Material for direct cutting	(K Grade) Precision Rolled Bar	(J Grade) Precision Rolled Bar
Diameter or Width across flats		± 1.5% but min. 0.4	± 1.0% but min. 0.3		+0 -0.4%	+0 -0.8%
Length		+40 0 to be applied only to material specified to be multiple-length				
Twist		To be within a practical range				
Bend		3 and below per 1000 and below per the whole length $\frac{3 \times \text{length}}{1000}$	To be decided by the agreement between orderer and manufacturer		(0.2 mm/200 mm or 1 mm/1m) and less	
Deviation in diameter		70% and below of the permissible variation of diameter or width across flats			To be decided by the agreement between orderer and manufacturer	
Square bar	Corner radius	10 to 20% of the width across flats			—	
	Sectional area	98% and over of the square of the minimum width across flats			—	
	Edge angle	90° ± 2°			—	

Remark: The rounding off of the numerical value shall comply with JIS Z 8401 "Rules for Rounding off of Numerical Values".

14. TEST

14.1 Test of chemical analysis

14.1.1 The sample for ladle analysis shall be taken according to the prescription in Section 3.2, JIS G 0303 "General Rules for Inspection of Steel".

14.1.2 The sample for product analysis of steel shall be taken according to the prescription in Section 3, JIS G 0321 "Product Analysis and its Tolerance for Wrought Steel".

14.1.3 Each element in steel sample shall be determined according to one of the following standards:

- NES M 0001 "General Rules on Methods of Chemical Analysis of Metallic Materials",
- NES M 0008 "Chemical Analysis of Silicon in Iron and Steel",
- NES M 0020 "Chemical Analysis of Manganese in Iron and Steel",
- NES M 0021 "Chemical Analysis of Phosphorus in Iron and Steel",
- NES M 0022 "Chemical Analysis of Sulfur in Iron and Steel",
- NES M 0023 "Chemical Analysis of Nickel in Iron and Steel",
- NES M 0024 "Chemical Analysis of Chromium in Iron and Steel",
- NES M 0025 "Chemical Analysis of Molybdenum in Iron and Steel",
- NES M 0028 "General Rules on Emission Spectroscopic Analysis of Metallic Materials (Photographic Photometry)",
- NES M 0029 "Chemical Analysis of Tungsten in Iron and Steel",
- NES M 0033 "Chemical Analysis of Lead in Iron and Steel",
- NES M 0042 "General Rules on Emission Spectroscopic Analysis of Metallic Materials (Direct-vision Photometry)",
- NES M 0085 "Chemical analysis of Tin in Iron and Steel",
- NES M 0088 "Chemical Analysis of Arsenic in Iron and Steel",
- JIS G 1202 "General Rules on Emission Spectroscopic Analysis for Iron and Steel",
- JIS G 1203 "General Rules for Photoelectric Spectro-Chemical Analysis of Iron and Steel",
- JIS G 1204 "General Rules for Fluorescent X-ray Analysis of Iron and Steel",
- JIS G 1211 "Method for Determination of Carbon in Iron and Steel",
- JIS G 1219 "Methods for Determination of Copper in Iron and Steel",
- JIS G 1221 "Methods for Determination of Vanadium in Iron and Steel",
- JIS G 1222 "Methods for Determination of Cobalt in Iron and Steel",
- JIS G 1223 "Methods for Determination of Titanium in Iron and Steel",
- JIS G 1224 "Methods for Determination of Aluminium in Iron and Steel",
- JIS G 1227 "Methods for Determination of Boron in Iron and Steel",
- JIS G 1228 "Methods for Determination of Nitrogen in Iron and Steel",

14.2 Tension test

- (1) The cold-finished steel shall be tension-tested according to JIS Z 2241 "Method of Tension Test for Metallic Materials".
- (2) The cold-finished steel shall be tension-tested with the No.2 or 4 specimen defined in JIS Z 2201 "Tension-Test Pieces for Metallic Materials", provided that the hot rolled steel for general structures use be tested with the No.2 or 3, and steel wire can be tension-tested with No.9 specimen.

Remark: For tension test of the D material 25 mm and below in diameter or width across flats, it is preferable to use the No. 2 specimen.

14.3 Bending test

- (1) The cold-finished steel shall be bending-tested according to JIS Z 2248 "Method of Bend Test for Metallic Materials".
- (2) The specimen for bending test of the cold-finished steel shall have the same profile as the original on each section and a suitable length.

14.4 Hardenability test

Hardenability test shall be carried out according to JIS G 0561 "Method of Hardenability Test for Steel" (End Hardening Process).

14.5 Grain size test

Grain size test shall be carried out according to JIS G 0551 "Method of Austenitic Grain Size Test for Steel".

15. INSPECTION

15.1 As for chemical composition, mechanical properties (in the case of cold-finished steel only), hardenability, grain size, decarburization, hardness, external view, internal quality, strength of residual magnetism and dimension, the steels shall comply with the prescriptions in Sections 4, 5, 6, 7, 8, 9, 10, 11, 12 and 13 as well as the agreement between orderer and manufacturer.

15.2 Besides the prescriptions in Section 15.1, it is possible to specify to the steels some necessary among the inspections enumerated in the following:

- (1) Magnetic particle inspection
- (2) Ultrasonic inspection
- (3) Macrostructure inspection
- (4) Streak flow inspection
- (5) Nonmetallic inclusions inspection
- (6) Mechanical properties inspection (hot-rolled steel)
- (7) Sulfur print inspection
- (8) Microscopic structure inspection

In this case, the orderer shall be beforehand agreed upon inspection item and acceptance criteria with the manufacturer.

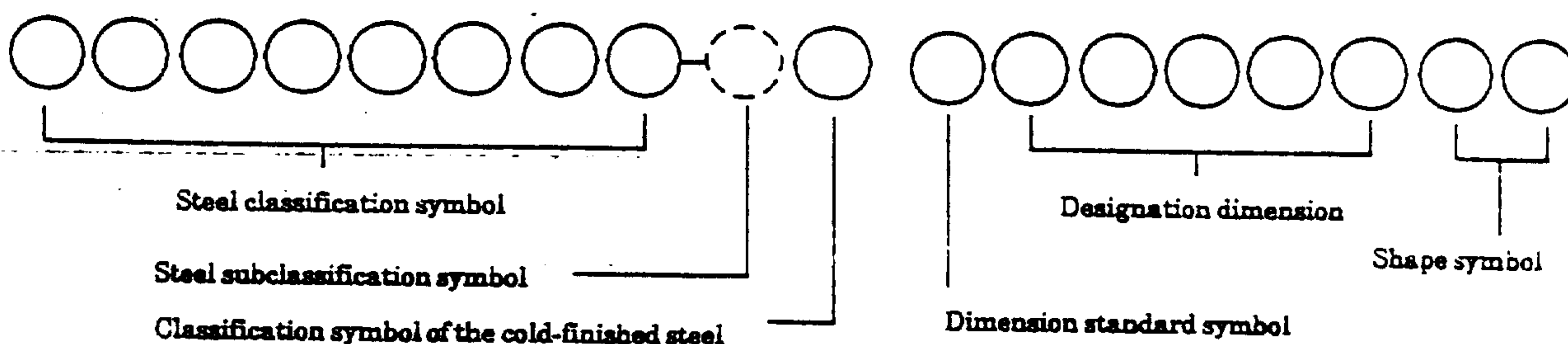
This sampling, specimen, testing method etc. shall comply with the corresponding prescription in the following standards:

JIS G 0303	"General Rules for Inspection of Steel",
JIS G 0553	"Macro-Structure Detecting Method for Steel",
JIS G 0555	"Microscopic Testing Method for the Nonmetallic Inclusions in Steel",
JIS G 0556	"Method of Macro-Streak Flaw Test for Steel",
JIS G 0560	"Method of Sulfur Print Test for Steel",
JIS G 0565	"Magnetic Particle Testing Method for Ferromagnetic Materials",
JIS Z 2201	"Tension Test Pieces for Metallic Materials",
JIS Z 2202	"Impact Test Pieces for Metallic Materials",
JIS Z 2241	"Method of Tension Test for Metallic Materials",
JIS Z 2242	"Method of Impact Test for Metallic Materials",
JIS Z 2344	"Ultrasonic Testing of Metals by Pulse Echo Technique".

16. DESIGNATION OF THE STEELS

16.1 Formation

The designation system of the steels shall be as follows:



Remark: For hot rolled flat and square bars as well as the cold-finished steel, no dimension standard symbol shall be indicated.

16.2 The steel classification symbol shall comply with Table 3.

16.3 In case a particular specification concerning chemical composition, hardenability etc., applied to each steel grade is to be separately subclassified, it shall be indicated, via a hyphen, with a one-digit figure after the steel classification symbol. The symbol of steel subclassification shall be agreed upon.

16.4 The dimensional standard symbol shall comply with Table 17.

16.5 As for the nominal dimension, the diameter or width across flats shall be indicated with a two to four-digit figure in unit mm. The nominal dimension of a flat bar shall be indicated via a symbol (X) as in distance between shorter sides X distance between longer sides.

18. IDENTIFICATION

The steels shall be identified according to the prescription in NES M 0083 "Identification of Steels".

19. REPORT

Manufacturer shall submit written specifications concerning the following items together with the steel products ordered every delivery lot of them, provided that some of these items can be omitted with the orderers approval:

Steel classification, dimension, number of steel making,
chemical composition, hardenability, number and weight of
the products and other specified ordered specification.

Diagram 2 H Band SCr415H

Steel classification	Chemical composition . . . (%)									Temperature of heat treatment (°C)	
	C	Si	Mn	P	S	Ni	Cr	Mo	Others	Normalizing	Hardening
SCr 415 H	0.12 ~0.18	0.15 ~0.35	0.55 ~0.90	0.030 and below	0.030 and below	—	0.85 ~1.25	—	Cu ≤ 0.30 Ni ≤ 0.25	925	925

Measuring distance (mm)		1.5	3	5	7	9	11	13	15	20	25	30	35	40	45	50
Hardness	Upper limit	46	45	41	35	31	28	27	26	23	20	(18)	(16)	(14)	(13)	(12)
HRC	Lower limit	39	34	26	21	(17)	(14)	(12)	—	—	—	—	—	—	—	—

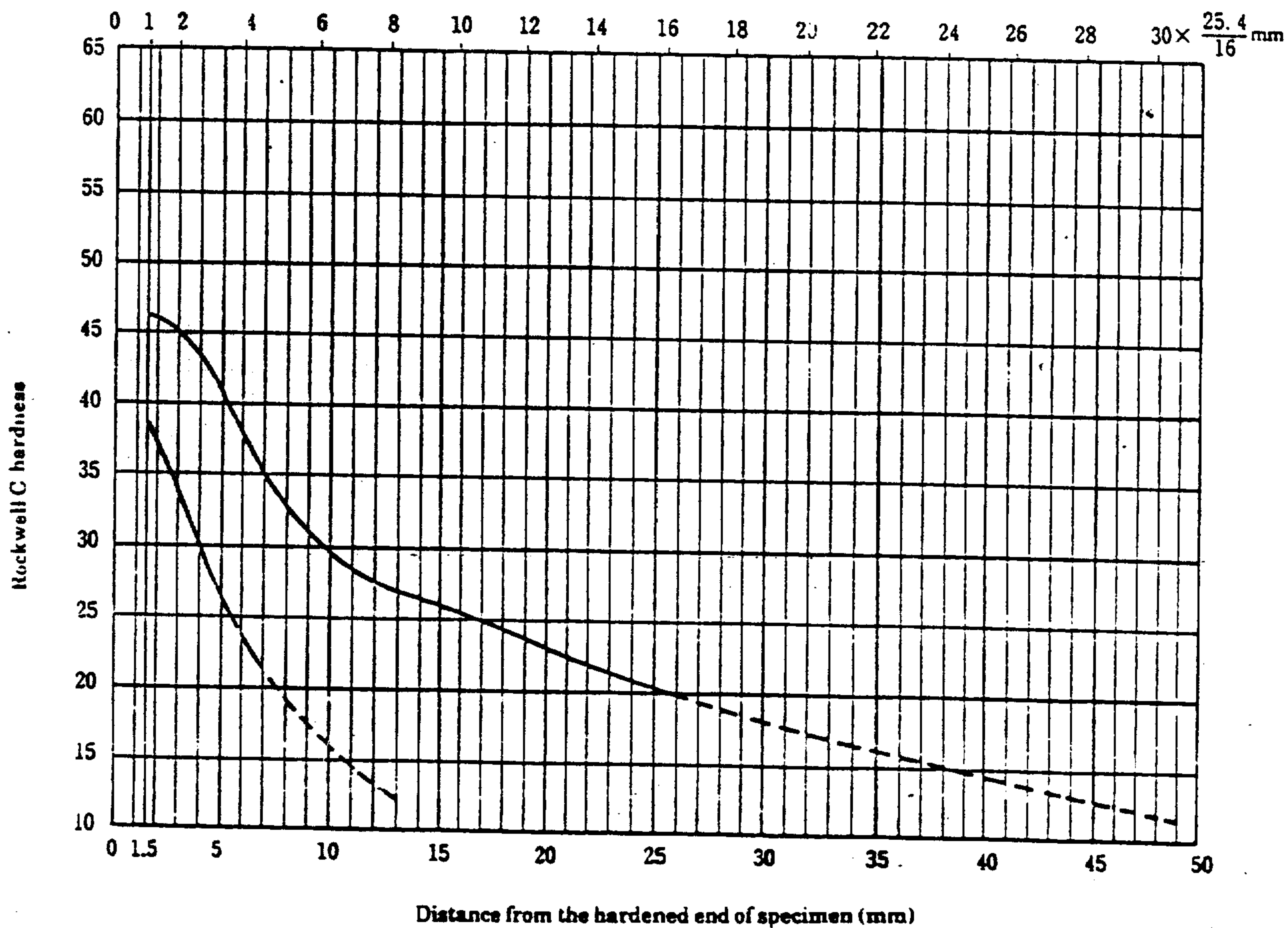


Diagram 4 H Band SCr40H

Steel classification	Chemical composition (%)									Temperature of heat treatment (°C)	
	C	Si	Mn	P	S	Ni	Cr	Mo	Others	Normalizing	Hardening
SCr 420 H	0.17 ~0.23	0.15 ~0.35	0.55 ~0.95	0.030 and below	0.030 and below	—	0.85 ~1.25	—	Cu ≤ 0.30 Ni ≤ 0.25	925	925

Measuring distance (mm)		1.5	3	5	7	9	11	13	15	20	25	30	35	40	45	50
Hardness	Upper limit	48	48	46	40	36	34	32	31	29	27	26	24	23	23	22
	Lower limit	40	37	32	28	25	22	21	(19)	(14)	—	—	—	—	—	—

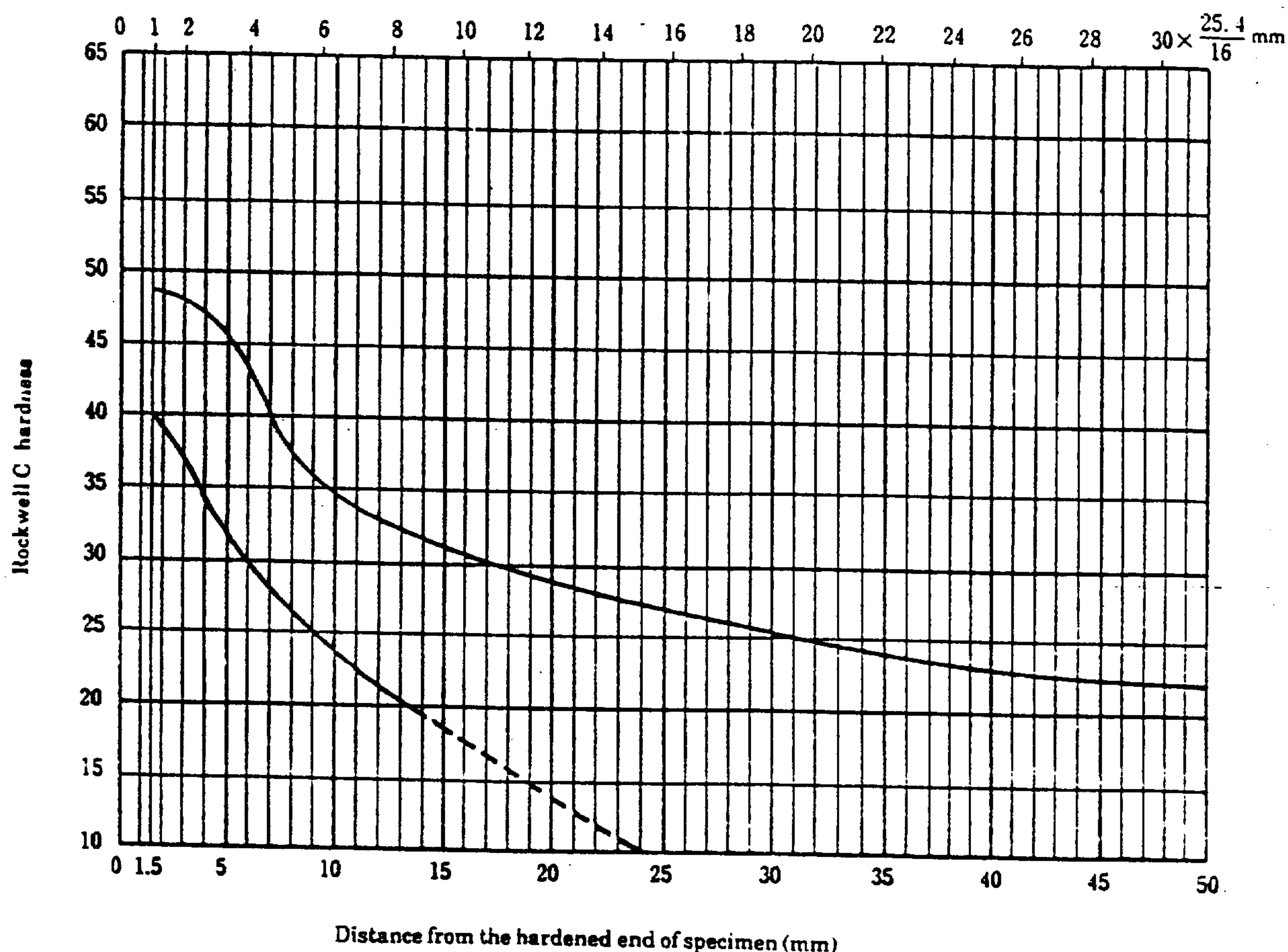


Diagram 6 H Band SCr445H

Steel classification	Chemical composition (%)									Temperature of heat treatment (°C)	
	C	Si	Mn	P	S	Ni	Cr	Mo	Others	Normalizing	Hardening
SCr 445 H	0.42 ~0.49	0.15 ~0.35	0.55 ~0.90	0.030 and below	0.030 and below	—	0.85 ~1.25	—	Cu ≤ 0.30 Ni ≤ 0.25	870	845

Measuring distance (mm)		1.5	3	5	7	9	11	13	15	20	25	30	35	40	45	50
Hardness	Upper limit	63	63	62	62	61	60	60	59	56	52	48	47	45	44	43
	Lower limit	56	56	55	53	52	49	46	43	37	33	32	30	29	28	26

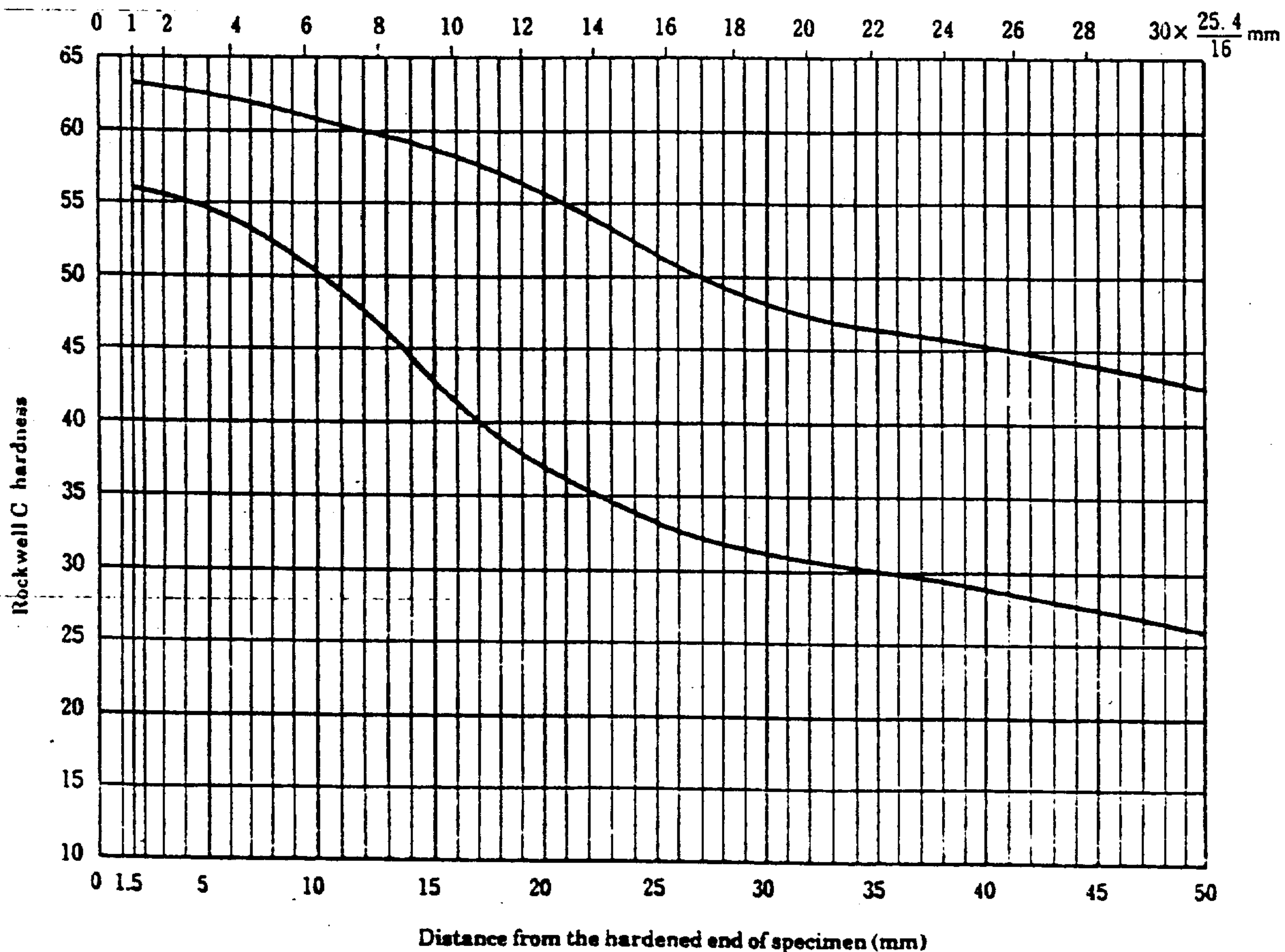


Diagram 8 H Band CB440H

Steel classification	Chemical composition (%)									Temperature of heat treatment (°C)	
	C	Si	Mn	P	S	Cr	Mo	B	Others	Normalizing	Hardening
MCB 440 H	0.37 ~0.44	0.15 ~0.35	0.80 ~1.10	0.080 and below	0.030 and below	0.70 ~1.10	—	0.0010 ~0.0030	Cu ≤ 0.30 Ni ≤ 0.25	870	845

Measuring distance (mm)		1.5	3	5	7	9	11	13	15	20	25	30	35	40	45	50
Hardness	Upper limit	60	60	60	59	58	58	57	56	55	53	51	49	47	46	44
	Lower limit	53	53	52	51	50	48	46	43	38	35	33	33	32	31	30

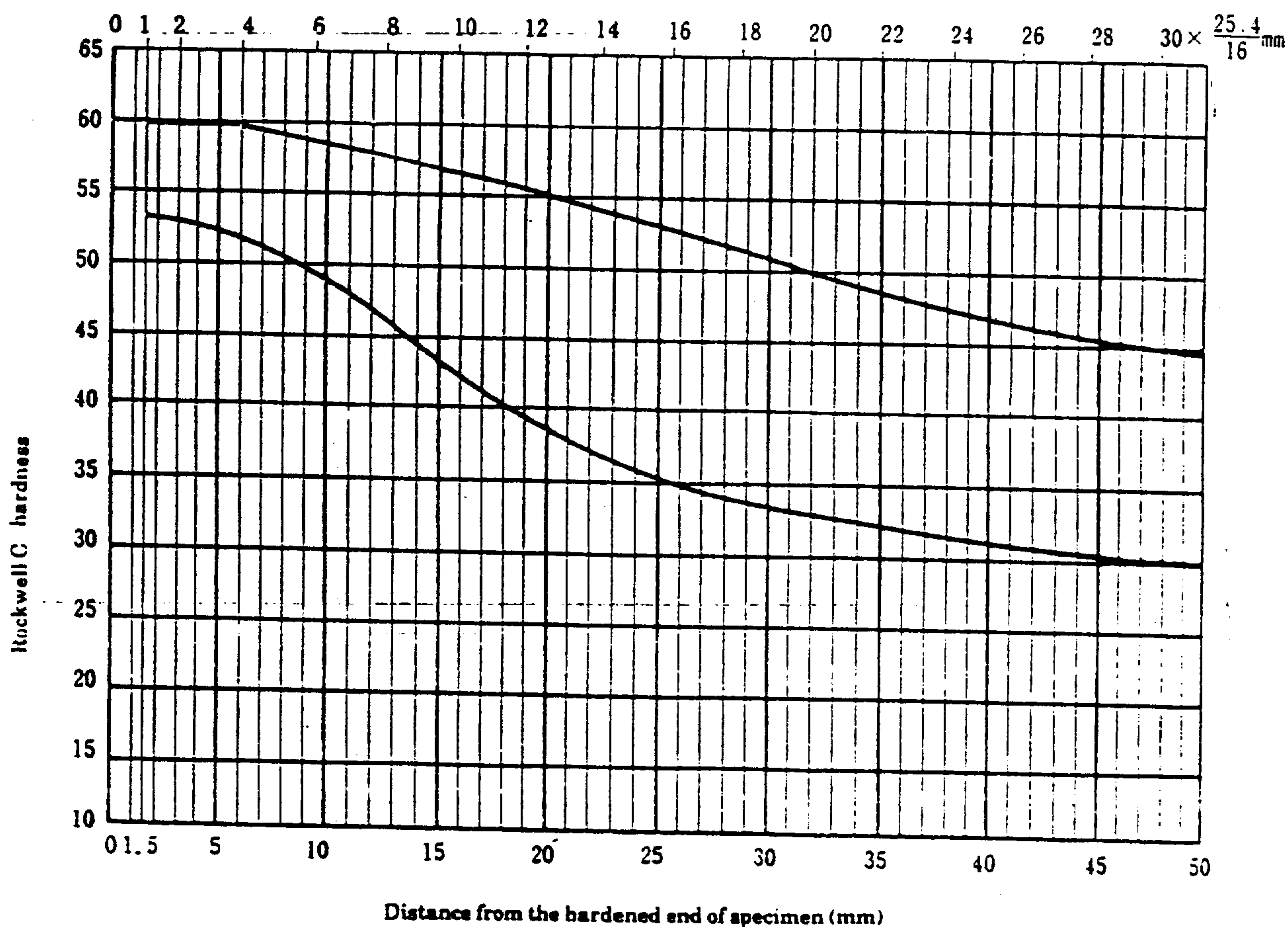


Diagram 10 H Band SCM418H

Steel classification	Chemical composition (%)									Temperature of heat treatment (°C)	
	C	Si	Mn	P	S	Ni	Cr	Mo	Others	Normalizing	Hardening
SCM 418 H	0.15 ~0.21	0.15 ~0.35	0.55 ~0.90	0.030 and below	0.030 and below	—	0.85 ~1.25	0.15 ~0.35	Cu ≤ 0.30 Ni ≤ 0.25	925	925

Measuring distance (mm)		1.5	3	5	7	9	11	13	15	20	25	30	35	40	45	50
Hardness	Upper limit	47	47	45	41	38	35	33	32	30	28	27	27	26	26	25
HRC	Lower limit	39	37	31	27	24	22	21	20	(16)	(14)	(12)	(11)	—	—	—

